

**EFFECT OF CHANNEL SIZE ON SWEET POTATO STORAGE ROOT
ENLARGEMENT IN THE TUSKEGEE UNIVERSITY
HYDROPONIC NUTRIENT FILM SYSTEM**

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ABSTRACT

The potential of the sweet potato as a food source for future long-term manned space missions is being evaluated for the National Aeronautics and Space Administration's (NASA) Controlled Ecological Life Support Systems (CELSS) program. Sweet potatoes have been successfully grown in a specially designed Tuskegee University nutrient film technique (TU NFT) system. This hydroponic system has yielded storage roots as high as 1790 g/plant fresh weight. In order to determine the effect of channel size on the yield of sweet potatoes, the width and depth of the growing channels were varied in two separate experiments. Widths were studied using the rectangular TU NFT channels with widths of 15 cm (6 in), 30 cm (12 in) and 45 cm (18 in). Channel depths of 5 cm (2 in), 10 cm (4 in) and 15 cm (6 in) were studied using a standard NASA fan-shaped Biomass Production Chamber (BPC) channel. A comparison of preliminary results indicated that, except for storage root number, the growth and yield of sweet potatoes were not affected by channel width. Storage root yield was affected by channel depth although storage root number and foliage growth were not. Both experiments are being repeated.

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Introduction

Research on the growth and yield of food crops in a controlled environment is currently being conducted by NASA through its Controlled Ecological Life Support Systems (CELSS) program for future applications on space missions. The sweet potato is one of eight crops initially selected by NASA to be used for the CELSS program (Wheeler and Tibbitts, 1984). Studies in progress at Tuskegee University are being directed toward growing sweet potatoes hydroponically to evaluate sweet potato production potential for CELSS and to better understand the physiology of storage root enlargement.

For several years, sweet potatoes have been grown in a specially designed Tuskegee University nutrient film technique (TU NFT) system (Loretan et al., 1988b). This system uses growth channels measuring 15 cm (6 in) deep x 15 cm wide x 1.2 m (48 in) long, and a storage root yield as high as 1790 g/plant (Hill et al., 1988) has been obtained. Sweet potatoes grown hydroponically in sand and perlite in different size pots showed no significant effect from pot size (Loretan et al., 1988a). However, the storage root yield tended to increase with increased pot size.

The objectives of the present studies are to evaluate the effect of various channel widths and depths on the yield of "Georgia Jet" sweet potatoes grown in the TU NFT system.

Materials and Methods

Experiment I

Four vine cuttings (15 cm) of the "Georgia Jet" sweet potato cultivar were planted into each of three TU NFT channels. The experiment used channels of standard depth and length (15 cm [6 in] and 1.2 m [48 in], respectively) with treatments of varying widths: (a) the standard - 15 cm [6 in]; (b) 30 cm [12 in] and (c) 45 cm [18 in]. A separate reservoir (30.4 liter capacity) for the nutrient solution was used for each treatment. A modified half-Hoagland nutrient solution was delivered to the plants in each channel at a flow rate of 1 liter/min. The nutrient solution was changed every 14 days or was topped with deionized water if the volume fell to 8 liters or less before the biweekly changeover date. Nutrient solution pH was kept at 5.5 to 6.0 and solution temperature, salinity and electrical conductivity were frequently measured. The ambient temperature within the greenhouse varied between 22° and 35°C, depending on weather conditions. The daytime irradiance level ranged from 200 - 2000 $\mu\text{mol m}^{-2}\text{s}^{-1}$. Supplemental cool white fluorescent (CWF) lighting was used on cloudy days. Carbon dioxide was at ambient level.

Experiment II

In a second experiment, "Georgia Jet" sweet potato vine cuttings (15 cm) were planted into three NASA fan-shaped channels (Prince et al., 1985). These channels have an overall length of 83 cm with

a maximum width of 42 cm at one end and a minimum width of 18 cm at the other. Three channel depth levels were used: (a) 5 cm (2 in)—standard for the Biomass Production Chamber, (b) 10 cm (4 in) and (c) 15 cm (6 in) (equivalent to the TU NFT channel depth). Methodology and growing conditions were similar to those listed in experiment I.

As the foliage grew in both experiments, the vines were trained to vertical strings dropping 1 m from above each channel. Plants were harvested 120 days after planting and storage root number and fresh weight as well as foliage fresh weights were taken. A 25 g sample of fresh storage root from each plant was dried in a 70°C oven for 48 h to provide percentage dry matter and storage root dry weight. Foliage and fibrous roots were dried in an oven at 70°C for 48 h and weighed to obtain dry weights.

Results and Discussion

The effects of three channel widths on the growth of “Georgia Jet” sweet potato are shown in Table 1. There was no effect of channel width on fresh or dry weight of foliage or storage roots. However, channel width influenced storage root number, with the 45 cm wide channel producing a significantly higher storage root number than either the 30 or 15 cm wide channels. The 45 cm channel width also tended to produce higher fresh storage root weight than the other two. Observations on the location of root enlargement within the channel showed that it took place more to the center of the channel except in the 15 cm channel where the roots made contact with the side walls. No storage roots were observed to have contacted the side walls in either the 30 cm or the 45 cm wide channels. Enlargement of the storage roots started at approximately the same distance (5 to 10 cm) from the plant stem in each treatment.

Table 1.
The effects of channel width on growth of “Georgia Jet” sweet potato plants* in a greenhouse using NFT.

Channel Width (cm)	Storage Roots			Foliage		Fibrous Roots
	No.	Fr. Wt. (g)	Dry Wt. (g)	Fr. Wt. (g)	Dry Wt. (g)	Dry Wt. (g)
45	4.8A	356.9A	79.8A	364.8A	60.0A	10.0
30	3.0B	303.0A	68.5A	319.6A	48.0A	8.0
15	2.5B	306.1A	65.5A	349.9A	46.3A	7.3

* Mean of four plants - means in the same column with the same letter are not significantly different using Duncan's Multiple Range Test at the 5% level.

The effects of channel depth on the growth of “Georgia Jet” sweet potato are shown in Table 2. The effect on storage roots was inconclusive. The number of roots tended to increase with channel depth, but there were no significant differences among channels. However, the largest fresh storage root weight (659.1 g per plant) was produced in the channel with the least depth (5 cm)—significantly higher than the 317.5 g per plant produced in the 10 cm channel. It was also higher than the 553.7 g per plant produced in the 15 cm channel depth although not significantly different. One storage root (815.7 g) in the 5 cm channel depth accounted for most of the yield in that channel. The dry storage root weights followed the same trend as the fresh weight. Even though the magnitude of the foliage weight, both fresh and dry, was in the same proportion as the storage roots, there were no significant differences among these treatments. The dry fibrous root weight also followed this trend. Thus there is no clear effect of channel depth. This may be due to an incidence of stem rot in some of the treatments. This experiment along with the experiment on channel width is presently being repeated so that the effect of channel size on the growth of “Georgia Jet” sweet potato may be clarified.

Table 2.
The effects of channel depth on growth of “Georgia Jet” sweet potato plants* in a greenhouse using NFT.

Channel Width (cm)	Storage Roots			Foliage		Fibrous Roots
	No.	Fr. Wt. (g)	Dry Wt. (g)	Fr. Wt. (g)	Dry Wt. (g)	Dry Wt. (g)
15	5.5A	553.7AB	91.0AB	561.0A	73.9A	10.5
10	3.0A	317.5B	51.1B	324.0A	50.3A	10.0
5	2.5A	659.1A	109.2A	616.0A	89.3A	13.0

* Mean of four plants - means in the same column with the same letter are not significantly different using Duncan's Multiple Range Test at the 5% level.

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